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Brewster, David H.; Fischbacher, Colin M.; Nolan, J.; Nowell, S.; Redpath, D.; Nabi, Ghulam

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Risk of hospitalization and death following prostate biopsy in Scotland

D.H. Brewster [a,b,*], C.M. Fischbacher [a,b], J. Nolan [a,1], S. Nowell [a], D. Redpath [a], G. Nabi [c,d]

[a] NHS National Services Scotland, Gyle Square, 1 South Gyle Crescent, Edinburgh, Scotland, UK
[b] Centre for Population Health Sciences, University of Edinburgh, Edinburgh, Scotland, UK
[c] Section of Academic Urology, Cancer Research Division, School of Medicine, Ninewells Hospital, Dundee, Scotland, UK
[d] Department of Surgical Urology, Ninewells Hospital, NHS Tayside, Dundee, Scotland, UK

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ABSTRACT

Objective: To investigate the risk of hospitalization and death following prostate biopsy.
Study design: Retrospective cohort study.
Methods: Our study population comprised 10,285 patients with a record of first ever prostate biopsy between 2009 and 2013 on computerized acute hospital discharge or outpatient records covering Scotland. Using the general population as a comparison group, expected numbers of admissions/deaths were derived by applying age-, sex-, deprivation category-, and calendar year-specific rates of hospital admissions/deaths to the study population. Indirectly standardized hospital admission ratios (SHRs) and mortality ratios (SMRs) were calculated by dividing the observed numbers of admissions/deaths by expected numbers.
Results: Compared with background rates, patients were more likely to be admitted to hospital within 30 days (SHR 2.7; 95% confidence interval 2.4, 2.9) and 120 days (SHR 4.0; 3.8, 4.1) of biopsy. Patients with prior co-morbidity had higher SHRs. The risk of death within 30 days of biopsy was not increased significantly (SMR 1.6; 0.9, 2.7), but within 120 days, the risk of death was significantly higher than expected (SMR 1.9; 1.5, 2.4). The risk of death increased with age and tended to be higher among patients with prior co-morbidity. Overall risks of hospitalization and of death up to 120 days were increased both in men diagnosed and those not diagnosed with prostate cancer.
Conclusions: Higher rates of adverse events in older patients and patients with prior co-morbidity emphasizes the need for careful patient selection for prostate biopsy and justifies ongoing efforts to minimize the risk of complications.

* *Corresponding author*. Public Health & Intelligence, NHS National Services Scotland, Gyle Square, 1 South Gyle Crescent, Edinburgh, EH12 9EB, Scotland, UK.
E-mail address: David.Brewster@nhs.net (D.H. Brewster).
[1] Now at the Centre for Clinical Brain Sciences, University of Edinburgh Medical School, Chancellor's Building, 49 Little France Crescent, Edinburgh, Scotland, UK.

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Introduction

Screening for prostate cancer using the prostate-specific antigen (PSA) test remains controversial. In a Cochrane review, based on a meta-analysis of five randomized trials, the authors concluded that screening does not reduce prostate cancer-specific and overall mortality; that harms associated with PSA-based screening and subsequent diagnostic evaluations are frequent, and moderate in severity; and that over-diagnosis and over-treatment are common and are associated with treatment-related harms.[1]

Limited information is published on the potential adverse consequences of prostate screening in real world clinical practice compared with appropriate control populations. The aim of this study was to investigate the risk of hospitalization and death following prostate biopsy in a cohort of patients selected from computerized hospital records in Scotland.

Methods

We performed a retrospective cohort study relating first ever prostate biopsy to hospitalization and/or death within 30 and 120 days. Record linkage was achieved using the Community Health Index number, a unique identifying number used by the National Health Service (NHS) in Scotland. We studied the first biopsy in any individual because the inclusion of every biopsy would result in a complex analysis, and the decision to undertake a subsequent biopsy may be influenced by complications arising after a previous biopsy.

The study population comprised patients with a record of first ever prostate biopsy between 2009 and 2013 inclusive on computerized acute hospital discharge or outpatient records covering the whole of Scotland (total population approximately 5.3 million). Patients were selected on the basis of procedure codes drawn from the fourth revision of the Office of Population Censuses and Surveys Classification of Surgical Operations and Procedures (OPCS-4)[2] (See Appendix). Endoscopic biopsies of prostate and open biopsies of prostate were not included. Diagnosis of prostate cancer within 120 days before or after prostate biopsy was established from linked Scottish Cancer Registry records.

Socio-economic position is likely to be an important confounding factor because men from less deprived areas of residence are more likely to have a PSA test,[3] but less likely to die from all causes combined. Therefore, the Scottish Index of Multiple Deprivation 2012 was used as a postcode-referenced, small area indicator of socio-economic position.[4] This has seven domains (income, employment, education, housing, health, crime, and geographical access) at 'datazone' level (areas with approximately 500–1000 household residents), which have been combined into an overall index to identify area concentrations of multiple deprivation.

In the context of this study, we sought to assess data quality in two ways. First, for a single region of Scotland (Tayside, total population approximately 414,000), we linked electronic pathology records for prostate biopsy to prostate biopsies on acute hospital discharge and outpatient records for the period 2009–2013. For this part of the study, we did not restrict the analysis to first biopsies. We determined the proportion of prostate biopsies that were unrecorded on hospital records and, of greater concern, the proportion of prostate biopsies recorded in error on hospital records. Second, for all Scottish patients identified as dying within 30 days of prostate biopsy, we reviewed their archived primary care records (or when these were inadequate, their electronic pathology record) to verify whether they had indeed undergone prostate biopsy within 30 days of death.

For the whole of Scotland, the numbers of prostate biopsies were examined in conjunction with numbers of admissions to hospital (continuous inpatient stays) and numbers of deaths, both within 30 and 120 days. Crude rates of hospitalization and death per 1000 patients were calculated for all patients combined, and also stratified by age group, deprivation fifth, prior co-morbidity, and whether diagnosed with prostate cancer. Reasons for admission to hospital were summarized for all patients combined, and separately for patients diagnosed or not diagnosed with prostate cancer. In particular, we focused on any mention of haemorrhage (e.g. haematuria), infection (e.g. urinary ± bacteraemia, rectal abscess), other urinary symptoms (e.g. retention, incontinence) and any mention of invasive procedures (e.g. catheterization). See Appendix for a detailed list of potentially relevant diagnostic (ICD-10) and procedure (OPCS-4) codes. Two indicators of prior co-morbidity, derived from hospital discharge data, were used: Charlson score based on primary diagnosis,[5] and prior inpatient bed days, both during the five year period immediately before prostate biopsy (but in the case of bed days, excluding the most recent six-month period, which would seem more likely to include some prostate-associated morbidity).

Indirectly standardized hospital admission ratios (SHRs) and mortality ratios (SMRs) were calculated by dividing the observed numbers of admissions/deaths by expected numbers. Again, results were stratified by subgroups, as described above. Both age and co-morbidity have been shown to predict the risk of mortality independently following prostate biopsy in previous research.[6] Follow-up was from date of prostate biopsy to 30/120 days after biopsy, or to date of death, whichever occurred first. For the hospitalization analysis, all continuous inpatient stays were counted. Using the general population as a comparison group, expected numbers of admissions/deaths were derived by applying age-, sex-, deprivation category-, and calendar year-specific rates of hospital admissions/deaths to the study population. Rates were calculated using population data sourced from National Records of Scotland. The 95% confidence intervals (CIs) around SHRs and SMRs were calculated based on the assumption that the observed numbers of admissions/deaths followed a Poisson distribution. SHRs and SMRs with 95% CI that do not include the value 1.0 were regarded as statistically significant.

Finally, for patients who died within 30 days of a prostate biopsy, their original death certificates were reviewed, taking account of the interval between biopsy and death, and the diagnoses listed, to assess whether the prostate biopsy might have contributed to their death.

Results

Data quality and representativeness

Data supplied by Tayside pathology laboratory included 1681 records of prostate biopsy. Computerized hospitalization data yielded only 508 records of prostate biopsy for patients treated in Tayside hospitals during the same period (2009–2013). Of these 508 records, 495 (97%) had a record of prostate biopsy within seven days of the corresponding pathology record, and 477 (94%) matched exactly for date of biopsy. Assuming pathology records to be the 'gold standard', and based on exact matching of dates, the sensitivity for detecting prostate biopsy using hospitalization records was only 28% (477/1681). Hospitalization records included a slightly higher proportion of patients aged ≥80 years (11% vs 7%; Chi-squared = 8.0; $P = 0.046$) but did not differ in terms of the distribution of deprivation categories (Chi-squared = 3.6; $P = 0.47$).

Across the whole of Scotland, we were able to verify that all 14 patients dying within 30 days of prostate biopsy (according to linked hospitalization and mortality records), had indeed undergone prostate biopsy ≤30 days before death.

Main results

The main study population included 10,285 patients undergoing first ever prostate biopsy (Table 1). At the time of their biopsy, the majority (80%) were aged ≥60 years, and 34% were aged ≥70 years. A higher percentage (27%) was from the least deprived compared with the most deprived (16%) areas of residence. The majority of patients (65%) had no recorded prior co-morbidity, and almost half (48%) were diagnosed with prostate cancer within 120 days of their biopsy. Although there is no clear pattern by age and deprivation, admission rates were higher in patients with prior co-morbidity, whereas mortality rates increased with age and prior co-morbidity. Although not shown in Table 1, the mortality rate within 120 days for patients aged <60 years was 2.8 per 1000.

The most common reason for hospital admission potentially associated with prostate biopsy was 'other urinary symptoms', although most admissions were not obviously associated with prostate biopsy, especially within 120 days of the procedure (Table 2). Compared to patients diagnosed with prostate cancer, patients not diagnosed had a higher percentage of potentially relevant complications recorded on their hospital admission records.

Compared with background rates, following prostate biopsy, patients were 2.7 times and 4.0 times more likely to be

Table 1 – Characteristics of the study population.

Characteristic	Patients		Admissions[a] within				Deaths within			
	No.	%	30 days		120 days		30 days		120 days	
			No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]
All patients combined	10,825	100.0	492	45.5	2929	270.6	14	1.3	67	6.2
Age group (years)										
<50	218	2.0	9	41.3	49	224.8	0	0.0	0	0.0
50–59	1948	18.0	88	45.2	593	304.4	0	0.0	6	3.1
60–69	4973	45.9	201	40.4	1361	273.7	3	0.6	24	4.8
70–79	3297	30.5	175	53.1	837	253.9	8	2.4	25	7.6
≥80	389	3.6	19	48.8	89	228.8	3	7.7	12	30.8
SIMD fifth										
1 – Most deprived	1770	16.4	103	58.2	510	288.1	3	1.7	13	7.3
2	1797	16.6	79	44.0	481	267.7	2	1.1	10	5.6
3	1989	18.4	80	40.2	545	274.0	4	2.0	15	7.5
4	2382	22.0	112	47.0	674	283.0	4	1.7	16	6.7
5 – Least deprived	2887	26.7	118	40.9	719	249.0	1	0.3	13	4.5
Prior co-morbidity (Charlson score)										
0 conditions	7058	65.2	290	41.1	1544	218.8	8	1.1	29	4.1
1–2 conditions	3754	34.7	202	53.8	1380	367.6	6	1.6	38	10.1
≥3 conditions	13	0.1	0	0.0	5	384.6	0	0.0	0	0.0
Prior co-morbidity (bed days)[c]										
0	7058	65.2	290	41.1	1544	218.8	8	1.1	29	4.0
1–10	3767	34.8	202	53.6	1385	367.7	6	1.6	38	10.1
≥11	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Diagnosed with prostate cancer[d]										
Yes	5227	48.3	218	41.7	1816	347.4	7	1.2	35	6.7
No	5598	51.7	274	48.9	1113	198.8	7	1.4	32	5.7

[a] Continuous inpatient stays.
[b] Rate per 1000 during 30 or 120 days, respectively.
[c] Number of inpatient bed days in the five years (excluding the most recent six months) before prostate biopsy.
[d] Within 120 days, before or after prostate biopsy date.

Table 2 – Numbers and percentages of patients admitted to hospital within 30 and 120 days, by reason for admission.

Reason for admission	Admissions within 30 days		Admissions within 120 days	
	No.	%	No.	%
All patients combined				
Haemorrhage[a]	14	2.8	62	2.1
Infection[a]	19	3.9	102	3.5
Other procedure-related complications[a]	0	0.0	2	0.1
Other urinary symptoms[a]	81	16.5	366	12.5
Multiple complications[b]	24	4.9	45	1.5
Other reasons	354	72.0	2352	80.3
Total[c]	492	100	2929	100
Patients diagnosed with prostate cancer[d]				
Haemorrhage[a]	4	1.8	22	1.2
Infection[a]	6	2.8	39	2.1
Other procedure-related complications[a]	0	0.0	1	0.1
Other urinary symptoms[a]	31	14.2	236	13.0
Multiple complications[b]	6	2.8	18	1.0
Other reasons	171	78.4	1500	82.6
Total[c]	218	100	1816	100
Patients not diagnosed with prostate cancer[d]				
Haemorrhage[a]	10	3.6	40	3.6
Infection[a]	13	4.7	63	5.7
Other procedure-related complications[a]	0	0.0	1	0.1
Other urinary symptoms[a]	50	18.2	130	11.7
Multiple complications[b]	18	6.6	27	2.4
Other reasons	183	66.8	852	76.5
Total[c]	274	100	1113	100

[a] Based on any mention of relevant ICD-10/OPCS-4 codes (See Appendix).
[b] Patients who fall into more than one of the preceding four categories.
[c] Total continuous inpatient stays.
[d] Within 120 days, before or after prostate biopsy date.

admitted to hospital within 30 days and 120 days, respectively (Table 3). There were no consistent patterns by age or deprivation, but patients with prior co-morbidity had higher SHRs. The risk of admission within 30 days was higher among patients not diagnosed with prostate cancer within 120 days of their biopsy compared with those diagnosed. However, this pattern was reversed with respect to admissions within 120 days of biopsy.

For all patients combined, the SMR within 30 days of prostate biopsy was increased modestly (SMR = 1.6) but the 95% CI includes the value 1.00, implying no statistically significant difference from background mortality rates (Table 4). However, within 120 days of biopsy, the risk of death was significantly higher than expected (SMR = 1.9; 95% CI 1.5, 2.4). No deaths occurred in the under 50 years age group within 120 days of biopsy, and only six occurred in the 50–59 years age group (Table 1). Although not shown in Table 4, the SMR within 120 days of biopsy for patients aged <60 years was 0.9 (95% CI 0.3, 1.9). The relative risk of death otherwise increased with age and tended to be higher among patients with prior co-morbidity. There was no obvious pattern by deprivation category. The risk of death within 120 days of biopsy was increased both in patients diagnosed (SMR = 2.1; 95% CI 1.4, 2.9) and not diagnosed (SMR = 1.8; 95% CI 1.2, 2.5) with prostate cancer.

Review of death certificates

We attempted to classify deaths within 30 days of biopsy as 'probably related', 'probably unrelated' or 'uncertain'. Four cases were classified as uncertain, and the remaining 10 cases as probably unrelated.

Discussion

In a large population of hospital patients undergoing first ever prostate biopsy, we found higher than expected risks of admission to hospital within 30 and 120 days of the procedure. The majority of admissions were for reasons not obviously associated with prior biopsy, and some admissions were most likely associated with the diagnosis of prostate cancer. However, the risk of hospital admission was increased both in patients with and without prostate cancer. Moreover, it is not appropriate to downplay complications arising in patients with prostate cancer since a proportion of these are likely to represent over-diagnosed cases.[7] It is also possible that some admissions for other reasons, such as cardiovascular disease, could be related to prostate biopsy.

There was no statistically significant evidence of an increased risk of dying within 30 days of a prostate biopsy, although it was not possible to estimate 30-day mortality precisely due to limited statistical power (14 deaths). Although the overall risk of death was almost doubled (SMR = 1.9) within 120 days of biopsy, and notwithstanding the challenges in determining and recording the true underlying cause of death,[8–10] more than a quarter of the deaths (18/67) were attributed to prostate cancer. However, as with hospital admission, the risk of death up to 120 days was

Table 3 – Standardized hospital admission ratios (SHR) with 95% confidence intervals (CIs) by patient characteristics.

Characteristic	Admissions[a] within 30 days			Admissions[a] within 120 days		
	SHR	95% CI		SHR	95% CI	
		LCL	UCL		LCL	UCL
All patients combined	2.7	2.4	2.9	4.0	3.8	4.1
Age group (years)						
<50	2.4	1.1	4.5	3.2	2.4	4.2
50–59	2.6	2.1	3.2	4.4	4.1	4.8
60–69	2.4	2.1	2.7	4.0	3.8	4.3
70–79	3.1	2.6	3.6	3.7	3.5	4.0
≥80	2.9	1.7	4.5	3.4	2.8	4.2
SIMD fifth						
1 – Most deprived	2.6	2.1	3.2	3.3	3.0	3.5
2	2.3	1.8	2.9	3.5	3.2	3.8
3	2.4	1.9	3.0	4.1	3.7	4.4
4	3.0	2.5	3.7	4.6	4.3	5.0
5 – Least deprived	2.9	2.4	3.4	4.4	4.1	4.7
Prior co-morbidity (Charlson score)						
0 conditions	2.4	2.1	2.7	3.2	3.1	3.4
1–2 conditions	3.1	2.7	3.6	5.4	5.1	5.6
≥3 conditions	0.0	NA	NA	5.1	1.7	12.0
Prior co-morbidity (bed days)[b]						
0	2.4	2.1	2.7	3.2	3.1	3.4
1–10	3.1	2.7	3.6	5.4	5.1	5.6
≥11	0.0	NA	NA	0.0	NA	NA
Diagnosed with prostate cancer[c]						
Yes	2.4	2.1	2.8	5.1	4.9	5.3
No	2.9	2.5	3.2	2.9	2.7	3.1

LCL, lower confidence limit; UCL, upper confidence limit; NA, not applicable.
SIMD, Scottish Index of Multiple Deprivation.
[a] Continuous inpatient stays.
[b] Number of inpatient bed days in the five years (excluding the most recent six months) before prostate biopsy.
[c] Within 120 days, before or after prostate biopsy date.

increased both in patients with and without prostate cancer. The risk of death was higher in older patients and those with prior co-morbidity, consistent with the findings of Gallina et al.[6] Although the mortality rate within 120 days of prostate biopsy for patients aged less than 60 years was slightly higher than that reported by Gallina et al. (2.8 compared with 2.0 per 1000)[6] and exceeds the threshold beyond which any years of life gained through PSA screening would be outweighed by years of life lost,[11] the calculation is based on a small number of events (six deaths) and corresponds to a SMR of 0.9 (95% CI 0.3, 1.9) implying no excess mortality risk in this age group. It is certainly possible that some or all of the deaths were not associated with prostate biopsy. Perhaps it is also worth noting that there was no evidence of excess mortality associated with prostate biopsy in either the ERSPC[12] or the PLCO[13] screening trials. However, it is also important to note that participants in trials of prostate cancer screening are likely to be asymptomatic and healthy. In contrast, in the absence of an organized prostate cancer screening programme in Scotland, our study population is likely to include a high proportion of men presenting with relevant symptoms.

Comparison with other observational studies is also challenging because of differences in profiles of study populations and control populations. Selection of an appropriate control population for men undergoing prostate biopsy is not straightforward. For example, Loeb et al.[14] found that biopsied men were at substantially decreased risk of death within 30 days compared with their control population (adjusted OR 0.29; 95% CI 0.22, 0.38). It seems implausible that prostate biopsy could reduce a man's risk of dying from all causes. The most likely explanation is that men selected for prostate biopsy tend to be healthier, on average. For the analyses reported in Tables 3 and 4, we used the general background population as our control population. It could be argued that this approach has led to an over-estimation of risks of complications on the grounds that men being investigated for possible prostate cancer might be expected to be at higher risk of hospitalization and death. However, as noted above, higher risks of hospitalization and death were also seen in men who were not diagnosed with prostate cancer.

As with mortality data, it can sometimes be difficult to be certain that hospital admissions are directly or indirectly associated with prior prostate biopsy. Nevertheless, many studies suggest that prostate biopsy can be associated with a range of subsequent morbidity, especially infection.[3,13,15–18]

The fact that 34% of prostate biopsies were carried out in men aged ≥70 years, coupled with higher rates of adverse events in older patients and patients with prior co-morbidity, raises the possibility that there may be scope to improve selection of patients for prostate biopsy. Even in the USA, where rates of PSA testing have been comparatively high

Table 4 – Standardized mortality ratios (SMR) with 95% confidence intervals (CIs) by patient characteristics.

Characteristic	Deaths within 30 days			Deaths within 120 days		
	SMR	95% CI		SMR	95% CI	
		LCL	UCL		LCL	UCL
All patients combined	1.6	0.9	2.7	1.9	1.5	2.4
Age group (years)						
<50	0.0	NA	NA	0.0	NA	NA
50–59	0.0	NA	NA	1.0	0.3	2.1
60–69	0.8	0.2	2.2	1.5	1.0	2.3
70–79	3.0	1.3	5.9	2.3	1.5	3.5
≥80	9.8	2.0	28.6	9.9	5.1	17.3
SIMD fifth						
1 – Most deprived	1.6	0.3	4.7	1.8	0.9	3.0
2	1.2	0.1	4.2	1.5	0.7	2.7
3	2.4	0.7	6.3	2.3	1.3	3.8
4	2.3	0.6	5.8	2.3	1.3	3.7
5 – Least deprived	0.6	0.0	3.2	1.9	1.0	3.2
Prior co-morbidity (Charlson score)						
0 conditions	1.4	0.6	2.8	1.3	0.9	1.8
1–2 conditions	2.0	0.7	4.3	3.1	2.2	4.3
≥3 conditions	0.0	NA	NA	0.0	NA	NA
Prior co-morbidity (bed days)[a]						
0	1.4	0.6	2.8	1.3	0.9	1.8
1–10	2.0	0.7	4.3	3.1	2.2	4.3
≥11	0.0	NA	NA	0.0	NA	NA
Diagnosed with prostate cancer[b]						
Yes	1.7	0.7	3.4	2.1	1.4	2.9
No	1.6	0.6	3.2	1.8	1.2	2.5

LCL, lower confidence limit; UCL, upper confidence limit; NA, not applicable.
[a] Number of inpatient bed days in the five years (excluding the most recent six months) before prostate biopsy.
[b] Within 120 days, before or after prostate biopsy date.

historically,[19] American Urological Association guidelines do not recommend routine PSA screening in men aged >70 years or in any man with less than a 10–15 year life expectancy.[20]

A strength of our study is that we were able to include some assessment of data quality. Our comparison with pathology records for one region of Scotland suggests that hospitalization data may exclude a high proportion of prostate biopsies. If outpatient biopsies are more likely to be performed on men at lower risk of complications, and less likely to be recorded in hospitalization data, our study may have over-estimated rates of complications. Hospitalization records included a slightly higher proportion of patients aged ≥80 years (11% vs 7%), but this seems unlikely to have distorted the results substantially. At the same time, misclassification of exposure to prostate biopsy, and the inclusion of men undergoing prostate biopsy in the background population used to calculate expected numbers of events, is unlikely to have had any appreciable impact because they represent such a small proportion of the entire population of men in Scotland. Of greater concern would be inaccurate coding of prostate biopsy in our study population yielding events that are not actually associated with a prior prostate biopsy. The overwhelming majority (97%) of hospital records had a record of prostate biopsy within seven days of the corresponding pathology record in our regional comparison, and we were able to verify that all deaths within 30 days of prostate biopsy (according to linked hospitalization and mortality records), had indeed undergone prostate biopsy ≤30 days before death. Against this background, we believe that our main study findings probably provide a reasonably accurate representation of the consequences of prostate biopsy in Scotland.

Other strengths include the size of the study population, which was derived from all public sector acute general hospitals in Scotland. The quality of cancer registration data, used to determine whether prostate cancer was diagnosed in each member of the study cohort, is believed to be comparatively good in Scotland, based on routinely available indicators,[21] and specific studies of completeness of case ascertainment[22] and data reliability.[23] A further strength was the ability to standardize for socio-economic deprivation.

A potential weakness of our study has been the reliance on clinical coding within hospital administrative data, not only to identify patients undergoing prostate biopsy but also to generate the Charlson index of (prior) co-morbidity and to identify reasons for subsequent hospital admissions. However, in Scotland, general hospitalization data are supported by an active programme of quality assurance including regular assessments of data quality.[24] As discussed above, it seems likely that prostate biopsy is usually coded correctly when recorded, but is often missing from hospital records. For all procedures and diagnoses, the overall accuracy of coding of main operation/procedure and main diagnosis has been estimated to be around 94% and 88%, respectively and has remained relatively stable for at least 20 years.[25] A further limitation of our study was that we were not able to capture

information on prostate biopsy-associated morbidity diagnosed and managed exclusively in hospital outpatient or primary care settings.

Our categories of prior co-morbidity, which were specified before analysis, resulted in very small numbers of cases in the highest categories of co-morbidity. Consequently, there was limited statistical power to detect excess risks of hospitalization or death in these categories.

Although we restricted our study to the first biopsy per patient, for the majority of the cohort (86%), this was their only biopsy recorded during the study period. However, it is important to acknowledge that we may not have identified the first biopsy for every patient, if some had a previous biopsy that was unrecorded in hospitalization data. Gallina et al.[6] found a higher risk of death for first ever compared with subsequent prostate biopsies, and other studies have found that repeat biopsy was not associated with a greater risk of serious complications compared with initial biopsy.[13,26,27]

Unfortunately, we did not have access to information on the reason(s) for biopsy, so we were not able to investigate whether, for example, men presenting with urinary symptoms were more likely to be hospitalized with urinary symptoms following their prostate biopsy.

In summary, we have shown increased risks of hospitalization and death in a cohort of men undergoing prostate biopsy. Although some events seem likely to be associated with a subsequent diagnosis of prostate cancer, it is likely that some are associated more directly or indirectly with prostate biopsy. The higher relative risk of events in older patients and patients with prior co-morbidity emphasizes the need for careful patient selection and justifies ongoing efforts to minimize the risk of complications.

Author statements

Ethical approval

Based on advice received from the South East Scotland Research Ethics Service (reference number NR/1404AB4), ethical review was considered not to be required because the project was an evaluation limited to using data obtained as part of usual care. However, the study was approved by the NHS National Services Scotland Privacy Advisory Committee (reference number PAC 29/14), and Caldicott Guardian approval was obtained from NHS Tayside to access and link pathology records for data quality assessment (reference number Caldicott/CSAppGN1358).

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Competing interests

None declared.

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Appendix

OPCS-4 procedure codes used to identify relevant prostate biopsies	
M70.1	Aspiration of prostate, NEC (not elsewhere classified)
M70.2	Perineal needle biopsy of prostate (includes needle biopsy of prostate NEC and biopsy of prostate NEC)
M70.3	Rectal needle biopsy of prostate
Codes for endoscopic biopsy of prostate (M45.2) and open biopsy of prostate (M62.2) were not included.	
Potentially relevant ICD-10 diagnostic and OPCS-4 procedure codes for hospital admission categories (See Table 2—based on any mention)	
Haemorrhage	
ICD-10	
D62.X	Acute posthaemorrhagic anaemia
K62.5	Haemorrhage of anus and rectum
N02.-	Recurrent and persistent haematuria
N42.1	Congestion and haemorrhage of prostate
R31.X	Unspecified haematuria
T81.0	Haemorrhage and haematoma complicating a procedure, not elsewhere classified
Infection	
ICD-10	
A41.-	Other septicaemia
A49.-	Bacterial infection of unspecified site
I33.-	Acute and subacute endocarditis
K61.-	Abscess of anal and rectal regions
K62.8	Other specified diseases of anus and rectum (including proctitis, NOS)
K65.-	Peritonitis
N15.1	Renal and perinephric abscess
N15.9	Renal tubulo-interstitial disease, unspecified (Infection of kidney, NOS)
N28.8	Other specified disorders of kidney and ureter (including pyelitis and pyeloureteritis)
N30.0	Acute cystitis
N30.3	Trigonitis (urethrotrigonitis)
N30.8	Other cystitis (abscess of bladder)
N30.9	Cystitis, unspecified
N34.-	Urethritis and urethral syndrome
N39.0	Urinary tract infection, site not specified
N41.-	Inflammatory diseases of the prostate
N45.-	Orchitis and epididymitis
N49.-	Inflammatory disorders of male genital organs, not elsewhere classified
T81.4	Infection following a procedure, not elsewhere classified
T83.5	Infection and inflammatory reaction due to prosthetic device, implant and graft in urinary system

Other procedure-related complications	
ICD-10	
T81.1	Shock during or resulting from a procedure, not elsewhere classified
T81.2	Accidental puncture and laceration during a procedure, not elsewhere classified
Other urinary symptoms	
ICD-10	
N39.3	Stress incontinence
N39.4	Other specified urinary incontinence
N99.8	Other postprocedural disorders of genitourinary system
N99.9	Postprocedural disorder of genitourinary system, unspecified
R32.X	Unspecified urinary incontinence
R33.X	Retention of urine
T83.0	Mechanical complication of urinary (indwelling) catheter
OPCS-4	
M47.-	Urethral catheterization of bladder